

# MMI-8S MULTI-AXES MOTION SYSTEM

## OPERATION AND INSTALLATION MANUAL

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## **INTRODUCTION**

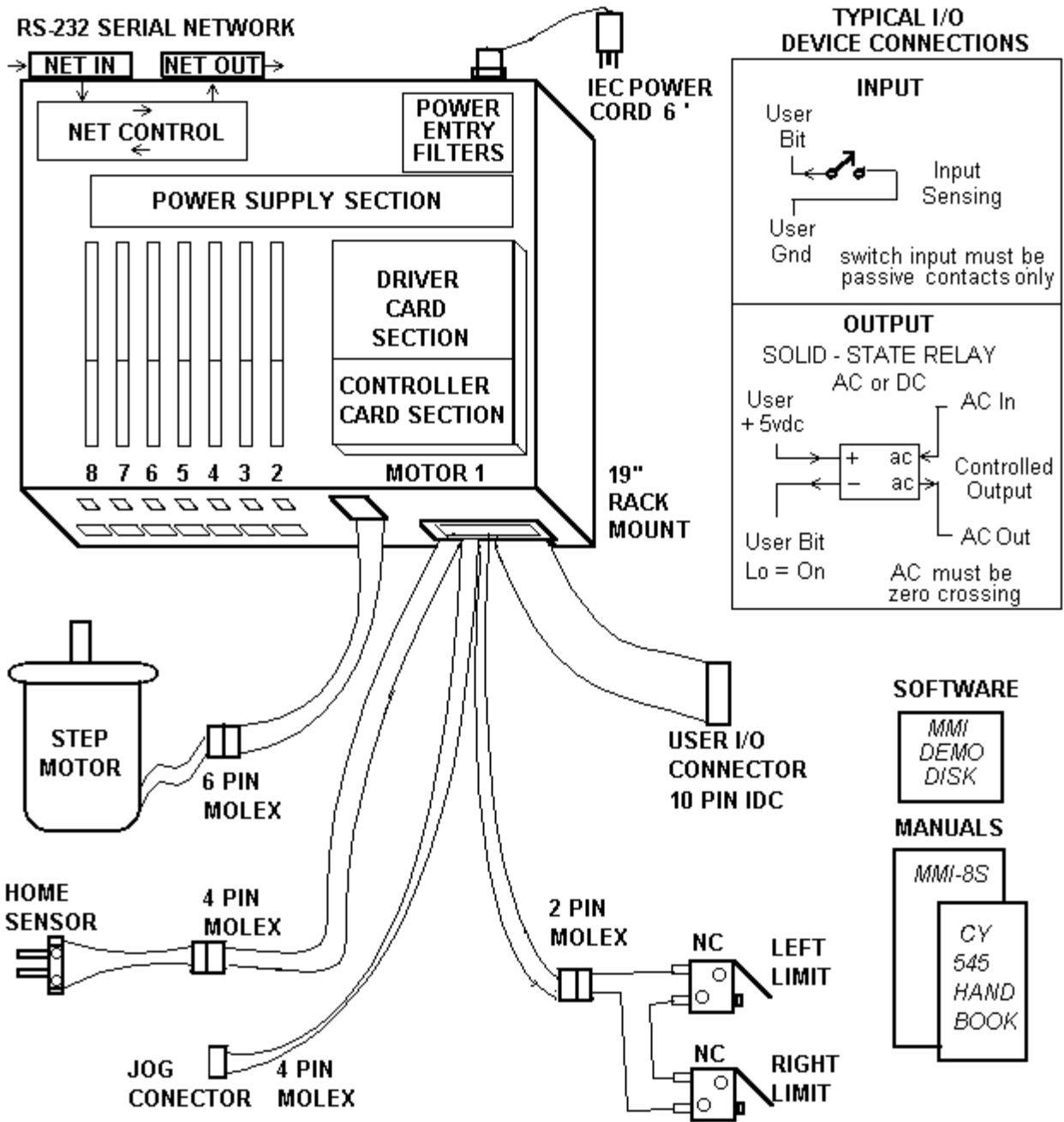
**MMI Multi-Axes Motion Controllers provide control of up to eight step motors. Each motor controller is independent. Each supports a home sensor, limit safety loop, and six bits of general purpose I/O (input/output). In addition, up to eight MMI motion controllers can be "daisy-chained" together with simple pin-to-pin DB9 serial cables for a total of 64 motors per serial port.**

**The MMI system consists of three major sub-assemblies: two SR4s (Serial Repeater 4-channel) network communication controller cards; up to eight SMCs (Step Motion Controller) cards; and the power supplies. The MMI system is packaged in a 19" format enclosure suitable for 19" rack mount or free standing (bench-top) applications.**

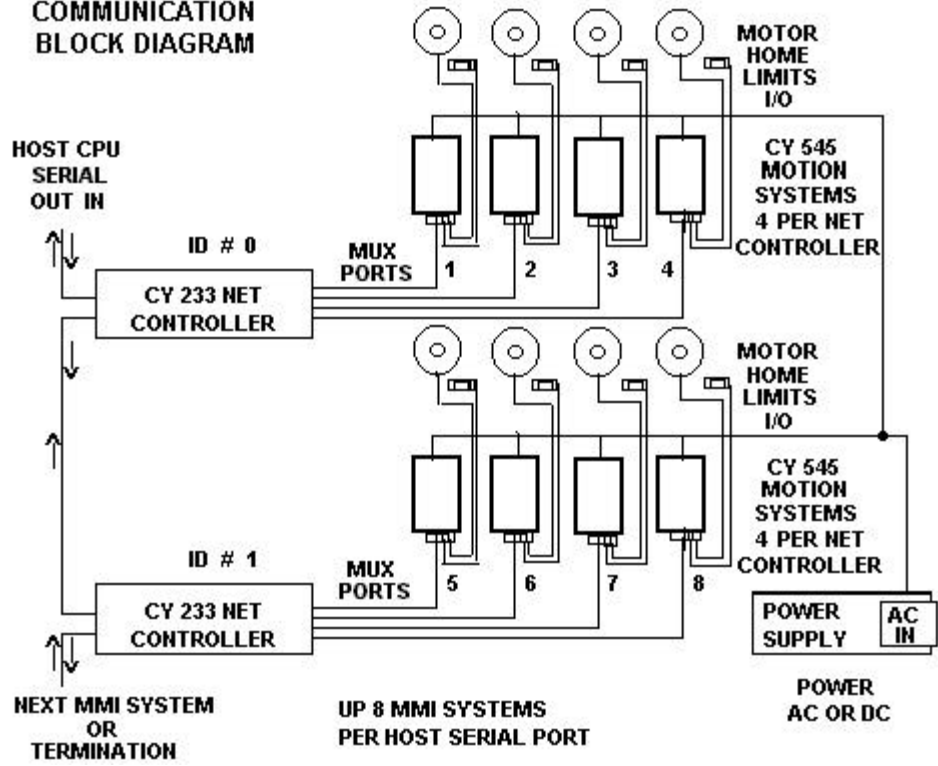
**During operation, the SR4 net controllers send and receive commands from the host CPU using the RS-232 communication port. There are 2 command sets; one for the Cybernetics CY233 net controllers and the other for the Cybernetics CY545 (550) SMC motor controllers. The CY233 uses only 4 commands. The CY545 has 26 commands; refer to the CY545 Motion Controller manual for details. The CY number refers to the model of microprocessor used in this system.**

# MMI-8S TURNKEY MOTION SYSTEM / COMPONENTS

MOTION IN MINUTES - PLUG AND GO SYSTEM - Features CY 545/550



**MMI MOTION SYSTEM  
COMMUNICATION  
BLOCK DIAGRAM**



## **DANGER**

**SUDDEN AND UNEXPECTED MOTION CAN OCCUR DUE TO PROGRAMMING ERRORS. STAY CLEAR OF THE MOTORS.**

## **WARNING**

**It is the user's responsibility to insure that commands are not sent to busy systems. The motion systems can indicate they are busy but have no way to block incoming communications which will either be lost or jam (lock-up) the system. In some cases, the system may begin uncontrolled motion.**

## **ATTENTION**

**CONTRARY TO POPULAR PRACTICE, IT IS BEST TO READ THIS MANUAL BEFORE ATTEMPTING TO OPERATE SYSTEM. IT WILL SAVE TIME AND PRODUCE BETTER, FASTER RESULTS.**

## SECTION 2: SR4 - Serial Repeater 4/channel Assembly

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### SR4 (CY 233) COMMAND SET SUMMARY

<b>WRITE</b>	<b>W</b>	<b>Send commands to the motion system.</b>
<b>READ</b>	<b>R</b>	<b>Read status (busy) of the motion systems.</b>
<b>ECHO</b>	<b>J</b>	<b>Used to set SR-4s into pass-through mode.</b>
<b>ENTER</b>	<b>&lt;</b>	<b>Carriage Return terminates commands.</b>

## **INTRODUCTION**

In the MMI system, two SR4 controllers are used. Each can control up to four SMC systems. During operation, a three byte net command (address), consisting of three bytes, is prefixed to a motion control command string. When the selected SR4 detects its address, a serial path is connected to the addressed SMC by a 1 to 4 serial data multiplexer. The motion command is then passed to the SMC. The command terminator character (carriage return) resets the multiplexer. Each motor command string must start with a net controller address. The controller address compares to the setting of the SR4 address switches in the MMI. The multiplex code selects any combination of the four output paths to the SMCs. For example, one motor system, at a time, is selected for setup commands and then up to four motors can be directed to execute (Go) simultaneously. When requesting information from a SMC motor system, only one of the eight can be selected.

When a motor system is performing an operation, its Busy signal is input to the SR4's status register. To monitor the busy status of the SMCs, a Read command (address), again consisting of three bytes, is sent to the net controller. The SR4 will return an ASCII character equal to a binary number. This number indicates the status of all four SMCs. Refer to the net ID address table in this manual.

The host to MMI serial port is wired with standard RS-232 (IBM type) DB-9 connectors. Each MMI has two connectors. The first goes to the host computer and the second to the next MMI controller in the daisy-chain. The last controller's second connector must be terminated with the "loop jumper" DB9 plug.

The MMI normally operates in standard RS-232 format using ASCII character mode at 1200 baud which supports the EEPROM memories on the motor cards. Optional baud rates up to 57K baud are possible. Parity is none, 8 data bits, and 1 stop bit.

## HARDWARE DESCRIPTION

The MMI network control contains two CY233 SR4 cards, generally referred to as #0 and #1 which is their binary address. Each card controls four SMC motor systems and includes status LEDs and jumber posts (dip-clips) for setting its ID number. The cards are mounted to a single rail and can be removed as a single unit as required during service.

**Note: Do not attempt any procedure or remove any screws other than instructed; no user service is possible to the interior assemblies!**

## SERVICE ACCESS

Remove the top cover (see following procedure) and access the interior of the MMI only: (1) to adjust the motor current (factory preset to 1 amp/coil); (2) to set the network address clips (factory preset to #0 & #1); (3) to observe the network LED displays during programming; as required.

## TOP COVER REMOVAL PROCEDURE

- (1) Remove only the four (4) corner 6/32 slotted-head screws holding the top, cover; the cover edges will be retained by the front and rear panels. black,
- (2) Pressing against the rear portion of the cover, at the raised bevel, with the thumbs, slide the cover fully forward while keeping the cover edge under the lip of the front panel. The rear lip of the cover will be exposed. Do not attempt to remove by sliding front to rear.
- (3) Using care not to bend the cover, lift up both rear corners of the cover slightly above the rear panel. Pull the cover towards the rear and lift off.
- (4) Replacement is the reverse of the above.

## OPERATION

The CY233 microprocessor is used as an address controller for the multiplex system. When a mode command, followed by a valid ID number, is received by the 233, the 233's address lines select a multiplex channel. The remaining serial data (motion command string) is passed, through the multiplexer, directly to the target device (motion system) until the detection of the terminator character (carriage return) by the 233. After detecting the terminator, the 233 resets the address lines and waits for the next mode command. If more than one controller is connected to the serial network, invalid ID numbers and the serial data string are echoed to the next controller down the line. If the ID is invalid for all controllers, the entire message will return to the host CPU (echo invalid).

**Note that contrary to normal CY545 procedure, in a CY233 network system, all SMC motor control commands MUST BE in LOWER case! All SR4 net commands must be in UPPER case!** With that said, it may be observed that the SMC's respond to upper case as well. Only during a query response will the SR4 repeaters strip off the upper case characters A to F which are seen as hex control codes. This will not cause a malfunction but may be confusing to the user.



## WRITE MODE

In general, SR4 mode commands are prefixed to SMC motion commands which are then "passed through" to the motion systems. Only two mode commands are used in this system, the write (W) and the read (R). A write command consists of a mode character (W), an ID number (two hex characters), a command string (motion system data string), and a terminator (carriage return). The ID number consists of two characters; the first or high byte is the system ID. This identifies an MMI net controller card. The system ID of a card is selected with the jumper switches located on the controller card. Valid ID numbers are from 0 to F hex (1 to 16 net controllers). The second or low byte selects any combination of the four channels within a controller. Valid channel numbers are from 0 to F hex. Note that F selects no motor channels and is used only to send the Status request to the CY233 and not the motion systems.

A typical example of a message to a SMC axes would be: W0Ep 1000<. This example directs SMC axis E (motor #1) of SR4 #0 to move to position 1000.

The write command is also used to request information (query) from the motion systems. Only one motion channel can be requested to return information at a time. In a typical motion system, with a CY545 motion controller, the question mark (?) command is used to query the system. Do not program the motion system EEPROMS to respond with information without a query command first (slave mode only).

A typical command would be: W0E? p<. This requests motor 1 to return its current position.

## READ MODE

A read command consists only of a mode character (R), the ID number (two hex characters; note that the second character is always F), and a terminator (carriage return). The read command is only used to read the status of the SMC motion systems from the SR4 net controller.

## STATUS

When a motion system is busy, it can not respond, normally, to the host computer. The BUSY (also referred to as the CTS or cleared-to-send) signal is used to hold off the host until, for example, a motion is completed. In the MMI system, the status of all four CTS signals is available as a single ASCII character. This character is equal to a binary number consisting of two bytes. The high byte is always 0010 (4 hex); the low byte consists of four bits; each bit indicates the status of a channel's CTS signal. Remember that the motion system MUST be in the Hand-Shake Mode (o 0a0h; lower case only) for the status function to be valid.

A typical command would be: R0F<; if the response was N, the binary value would be 0010 (fixed) 1110. Refer to Code Table.

## **ECHO MODE**

In the MMI network system, with two network cards, it is necessary to engage the CY233 pass-through (echo-all) mode. This allows commands originating in a motion channel (SMC) to be passed through successive SR4 cards down-stream in the network loop. A typical example is the SMC system query commands. The J command format consists of a mode character (J), the ID number (two hex characters; the second is always F), and the terminator (carriage return).

A typical command would be J0F<; the 0 is the address of the first SR4 card and the F indicates a SR4 only message; J1F is the second card address. Each SR4 in the daisy-chain network must be sent a J command during start-up procedure.

## **ID AND STATUS CODES**

Referring to the following table, note that the codes seem confusing in that they are not an orderly sequence of decimal numbers. They, in fact, are based on their hex-decimal values from 0 to F (hex) . Also as the active selection signal is a LOW or 0 volts, the sequence is inverted. For example, all devices selected is a 0 (zero) code or address; all bits are low. No devices selected is F; all bits HI (+5 volts). Therefore, selection of the first device or E indicates 1 bit is LOW; all others are HI. Note that the codes for the individual motor controllers are therefore E (motor #1), D (motor #2), B (motor #3), and 7 (motor #4). The other codes allow selection of any combination of motors. The BUSY codes correspond to these selections with the @ indicating all BUSY followed by A to O (none busy) in decending order. Refer to PROGRAMMING section for examples of code selection.

## TABLE OF ID AND STATUS CODES

CONTROLLER ID ADDRESS [MSD]			OUTPUT ADDRESS [LSD]			READ BUSY CODE
HEX	BINARY	DECIMAL	HEX	BINARY	FUNCTION	ASCII
F	1111	15	F	1111	READ BUSY CODE	O = NONE
E	1110	14	E	1110	WRITE TO PORT 1	N = 1 BUSY
D	1101	13	D	1101	" 2	M = 2 BUSY
C	1100	12	C	1100	" 1 & 2	L ( etc )
B	1011	11	B	1011	" 3	K
A	1010	10	A	1010	" 3 & 1	J
9	1001	9	9	1001	" 3 & 2	I
8	1000	8	8	1000	" 3 & 2 & 1	H
7	0111	7	7	0111	" 4	G
6	0110	6	6	0110	" 4 & 1	F
5	0101	5	5	0101	" 4 & 2	E
4	0100	4	4	0100	" 4 & 2 & 1	D
3	0011	3	3	0011	" 4 & 3	C
2	0010	2	2	0010	" 4 & 3 & 1	B
1	0001	1	1	0001	" 4 & 3 & 2	A
0	0000	0	0	0000	" 4 & 3 & 2 & 1	@



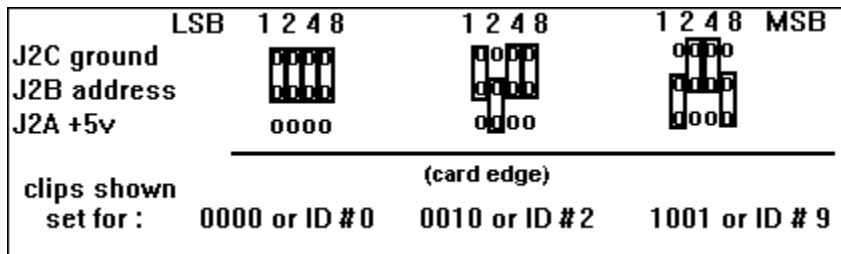
## LED DISPLAYS

The displays are used with the test software program to verify and demonstrate correct operation of the MMI. They are located on each SR4 card; inside the MMI.

L 1	OUT 1	INDICATES TRANSMIT DATA TO CHANNEL	1
L 2	OUT 2	"	2
L 3	OUT 3	"	3
L 4	OUT 4	"	4
L 5	OUT DATA	INDICATES TRANSMIT DATA FROM HOST CPU	
L 6	IN 1	INDICATES RECEIVE DATA TO HOST CPU	1
L 7	IN 2	"	2
L 8	IN 3	"	3
L 9	IN 4	"	4
L 10	AD 0	INDICATES MOTION CHANNEL ADDRESS	1
L 11	AD 1	"	2
L 12	AD 2	"	3
L 13	AD 3	"	4

## ID JUMPER SWITCH

The ID jumper switch assigns the ID number to an SR4 card. The switch consists of 3 rows of 4 posts. The center row is jumpered high or low according to the required number. The rows are labeled J2A (high posts), J2B (signal), and J2C (low posts). All posts must be jumpered. If additional MMI units are used, their addresses must be set according to their position in the daisy chain.



## PROGRAMMING

The MMI is, in general, transparent to the connected motion systems and requires only that the three byte address be pre-fixed to the existing commands.

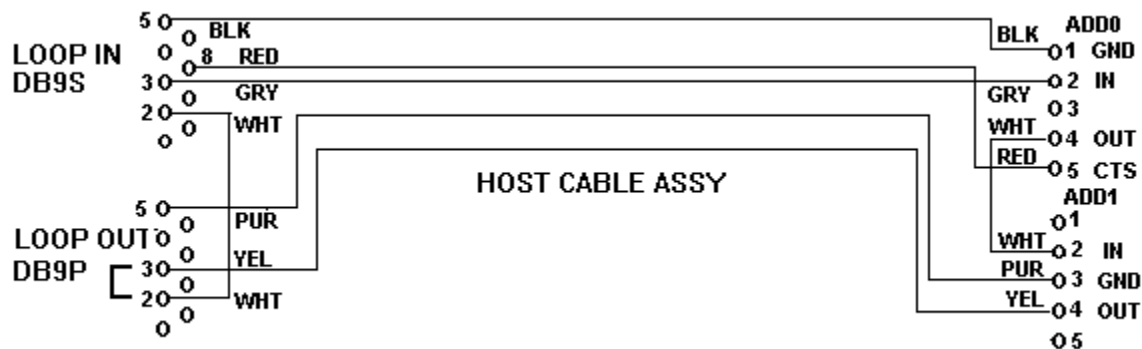
The demonstration software furnished with the MMI is intended to exercise the entire unit and to allow transmitting commands one at a time or in complete strings in order to verify operation of the system or to create a complete simulation of the application. This software is a simple terminal program whose listings contain important notes. All users should read the listing for this general information about system operations. Refer to the sample program in the Installation and Operation section of this manual.

## NETWORK CONFIGURATION (DAISY CHAIN) BLOCK DIAGRAM & CABLES

### SR-4 HOST CABLE (NETWORK) ASSEMBLY

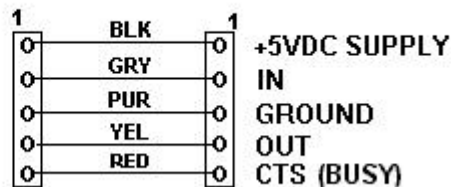
P5-1 GROUND	DB9S-5	GROUND	BLACK
P5-2 TXD DATA IN	DB9S-3	LOOP INPUT	GRAY
P5-3 GROUND	DB9P-5	GROUND	PURPLE
P5-4 RXD DATA OUT	DB9P-3	LOOP OUTPUT	YELLOW
P5-5 +5 VDC	DB9S-8	CTS ALWAYS NOT BUSY	RED

DB9S-2 LOOP RTN DB9P-2 LOOP RTN WHITE JUMPER

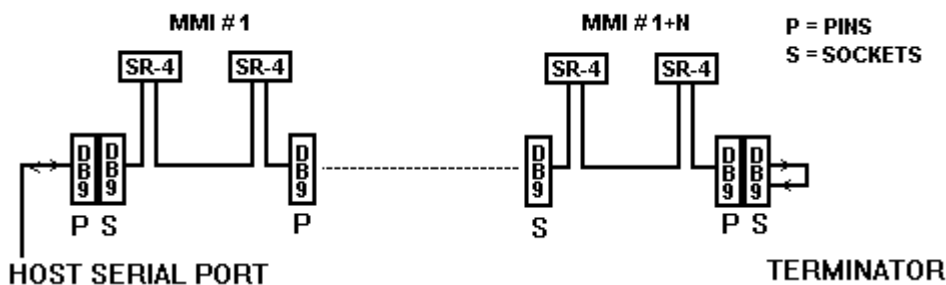


### DB9P DEVICE CABLE ASSY 4 EA. / CARD

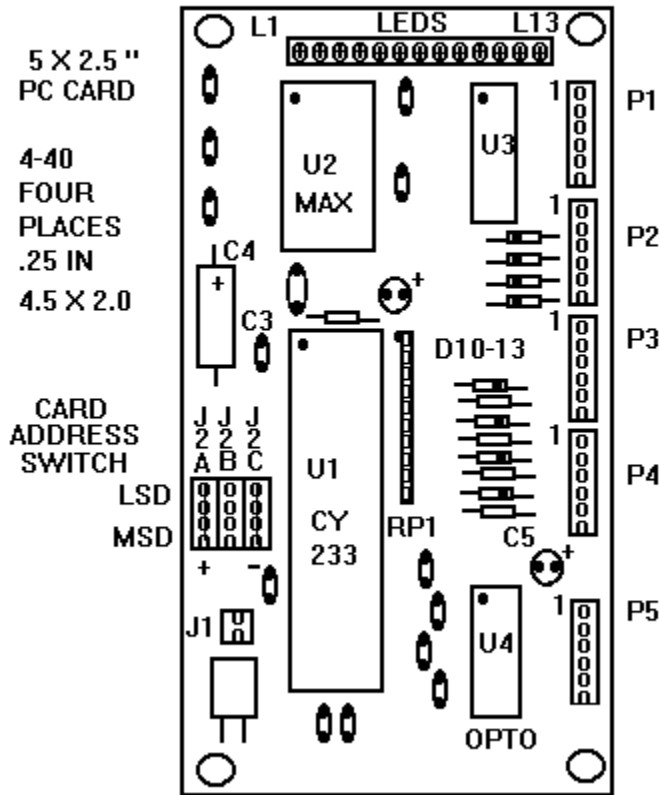
P5-1 +5 VDC  
 P5-2 TXD DATA IN  
 P5-3 GROUND  
 P5-4 RXD DATA OUT  
 P5-5 CTS (NOT BUSY)



### NETWORK CABLING DIAGRAM



## SR - 4 CARD & CABLE PINOUTS



### CHANNEL CONNECTORS P1 P2 P3 P4 TYPICAL

P1-1 +5 VDC  
 P1-2 TXD DATA OUT  
 P1-3 SYSTEM GND  
 P1-4 RXD DATA IN  
 P1-5 CTS BUSY

### HOST CONNECTOR

P5-1 SYSTEM GND  
 P5-2 TXD DATA OUT  
 P5-3 SYSTEM GND  
 P5-4 RXD DATA IN  
 P5-5 +5 VDC {CTS}

## SECTION 3: SMC - STEP MOTION CONTROLLER ASSEMBLY

### ALSO REFER TO:

Cybernetic Micro Systems - CY 545 Step Motor Controller Manual

MMIDEMO program - Software Listings & Comments

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### CY 545 COMMAND SET SUMMARY

(In the MMI network system, all letter commands must be in lower case)

<u>Command</u>	<u>Function</u>	<u>Note</u>
A val 24	set position counter to At value	Commands are lower case ASCII letters, followed by a space, and a value if required. Values without a suffix are 0 to 255 max. Values with 16 suffix are 65535 (64K) max. Values with 24 suffix are 16777215 (16 Meg). Add (byte count) is 64K max. Bit # is 0 to 7.
B bit #	set or clear (/B) User Bit	
C	set Continuous stepping mode	
D val 16	Delay for value in milliseconds	
E	Enter commands to user mem	
F val	First (starting) speed of motor	
G	motor Goes the number of steps	
H bit #	Home motor on bit #	
I	Initialize 545; software reset	
J add	Jump to address on mem page	
L cnt add	Loop to address for count value	
N num 24	Number of steps; see Go	
O mode	set mOdes of CY controller	
P val 24	moves to an absolute Position	
Q	Quit Enter commands to mem	
R val	set Ramp (top) speed of motor	
S val	Slope (acceleration) of F to R	
T bit # add	jump to add unTil Bit matches	
W bit #	Wait at add until Bit matches	
X	eXecute commands at Y add	
Y add 16	set mem address counter to Y	
Z cnt 16 add	Zillion Loops to add for cnt value	
0 (number)	end of program or stop program	
+ (plus)	set CW direction for Go move	
- (minus)	set CCW direction for Go move	
/ (for slash)	negate prefix for /Bit commands	
? command	send back command val to host	
"message"	send back message to host	

**!!!! ATTENTION !!!!**

Mis-wiring of motor or power supplies **WILL** damage motor drivers **IMMEDIATELY**. Motor coils A or B can be reversed; motor will run in the opposite direction. Pairs can be reversed; pair A in coil B for example. **CROSS-WIRING**, an A and B wire crossed, **WILL** damage driver. Allowing exposed motor leads to touch each other, ground, or power **MAY** damage driver. Refer to Appendix D in the MS driver section for wiring schemes.

**SMOKE, POPPING, ELECTRONIC ODOR, OR FUSE FAILURE  
INDICATES DRIVER FAILURE.**

Call the Service Center. Do **NOT** change fuse or attempt repair without instructions. **ADDITIONAL DAMAGE CAN OCCUR !!!** Shorted drivers can easily be repaired by replacing the socketed driver arrays.

**!!!! WARNING !!!!**

**NEVER** connect or disconnect any of the motor leads or power supply (VMM) leads before disconnecting AC power! Unit may be safely operated **WITHOUT** motor. However, pause 30 seconds after power off before reconnecting motor (Bleed-Down time).

**NOTE !**

An understanding of the Cybernetic Motion Controller and its Command Set is required in the following explanations . Refer to the Cybernetic Micro Systems - CY 545 OR 550 Step Motor Controller Manual.



## **Introduction**

The SMC motion control system consists of two basic elements; the controller card and the MS driver card. The controller card (CY5.4) contains the Cybernetic CY 545 or CY 550 Step Motor Controller and a 2K character EEPROM (non-volatile) for storing application routines. Refer to the Cybernetics 545 manual for a description of the 545 microprocessor and its "High-Level" command set (26 characters and symbols). All actions of this system are controlled by these commands.

Two of the eight User Bits of the 545 (USRB 0-7) are assigned to a specific function. The remainder are for general purpose Input and Output functions (I/O) such as controlling relays or valves (output) and reading switches (input). The command set of the Cybernetic 545 contains instructions such as Test, Wait, Delay, Loop which are used along with the motion instructions to provide a wide range of machine operations. The SMC system can also be described as a "mini-PLC with motion".

The Step pulses and the Direction signal from the CY5.4 controller are connected to the motor driver. Additionally, the Stop (PWR LED) signal shifts the driver from Park power to Full power. A Home Sensor channel is also part of the system.

Each system includes a CI cable (controller interface cable). This 20 pin cable is divided into two sections. The I/O section contains + 5 v power and ground as well as six User Bits. The Chassis section connects the Home Sensor, User Bit 2, Jog Switch, and Limit Loop signals back to the controller. Refer to Appendix A for details.

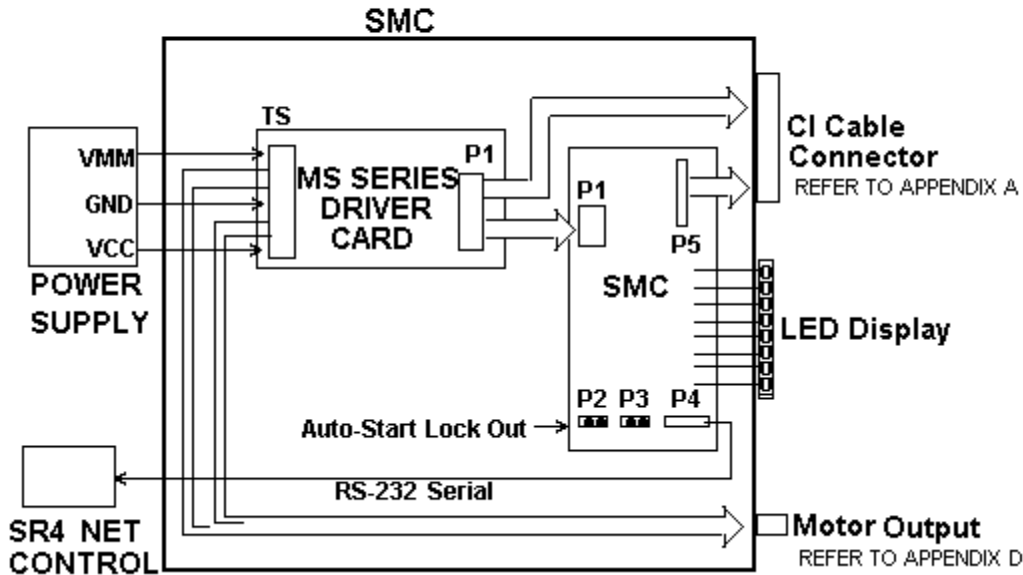
This system is self-contained and can operate independently or under the direct command of a host computer. In Memory Mode, the host computer is used to "teach" the system by sending a string of commands which are stored, for later execution, in the on-board memory of the controller card. In Direct Mode, the host commands are executed immediately by the CY545. A combination of these two modes is also possible; typically macro command strings are loaded to memory and then executed as required by the host.

See Appendix A for CI cable  
See Appendix B for homing / limits  
See Appendix C for current adjust

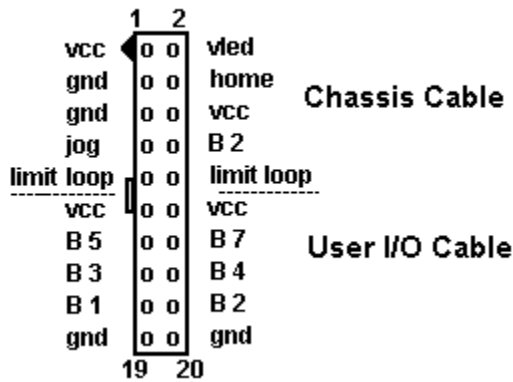
See Appendix D for motor wiring  
See Appendix E for driver card  
See Appendix F for home sensor

## SMC BLOCK DIAGRAM

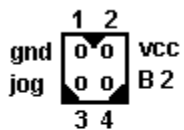
The SMC system consists of motor driver card and motion controller card. Refer to specific section for details.



### CI CABLE CONNECTOR



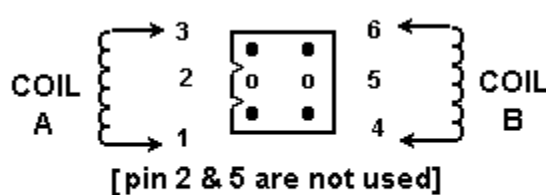
### JOG CONNECTOR



REFER TO APPENDIX A

Molex Connector pin numbers are embossed on back of nylon housing

### MOTOR CONNECTOR



REFER TO APPENDIX D

## Hardware Configuration

The SMC controller card contains the CY 545 motion controller, EEprom memory, memory latches (2 each), RS-232 receiver / driver, LED status lites and standard crystal (11 MHZ). Refer to the Rate Table in the CY545 manual.

## Serial Format

The SMC is connected as a RS-232 serial device and communicates with the host computer through the SR4 network. The serial format is configured in the following manner: ASCII characters, 1200 Baud, 8 data bits, no parity, and one stop bit. The CTS (Clear To Send) feature of the 545 (User Bit 6) is used as the hardware hand-shake to control communication between the host and the 545. When the 545 is busy, it will set the CTS signal to the SR4 status register as a request to hold off transmission.

During operation from memory or when homing, the CTS function is not 100% busy; pulses on/off each instruction. This is to allow interruption of routines by the host computer sending a stop command (0 or CR). If other data is sent, incorrect operation will result. To set the SMC 100% busy during operations: (1) disable the CTS function with the Mode command. User Bit 6 will set HI or busy. (2) As the last instruction, in the memory routine, re-enable the CTS.

**NOTE:**       the correct Mode command to defeat the CTS is:   o 080h.  
              the correct Mode command to enable the CTS is:  o 0a0h  
              (Any hex value starting with a letter must be preceded by a zero)

Memory Format. The memory is configured as 2K bytes of EEPROM (RAM is optional). It is not possible to access memory above address 2047. Note that the memory is in pages of 256 bytes; the CY545 does not allow Jump, Test, or Loop operations across page boundaries. The pointer command (Y) is used to move across boundaries. A feature of the 545 memory system, the Auto-Start function which recognizes special character flags in the first bytes of memory as a command to run the following program at power-on, is not used in the MMI.

Home Function. This system uses an optical sensor to establish the starting reference or "Home" position at power-on; refer to the Home command (H). Lash-Compensation is included in the home routine. A major advantage of this system is Slip-Detection which provides operation to  $\pm$  zero steps. See Installation and Test for a detailed home procedure.

Limit Loop Function. The CW-CCW Limits function of the 545, pin 4 & 5, is not used in this system. Instead, the driver card will go "free or ABoRt" (CURRENT-OFF) when the Limit Loop is opened (Fail-Safe, Hard-Soft limits). This Limit Loop is enabled by User Bit 0. Refer to the Appendix B section of this manual.

**I/O Function.** The Cybernetic User Bits are available at the CI cable connectors and can be used as either inputs or outputs dependent on the command. Note that an output can only drive LEDs such as those in Solid-State relays or optical isolation. An input can only be a passive switch or isolated relay contact across the User Bit and User ground. **Connecting any device, at a different potential, to this system through the User Bits, WILL damage the User port; opto-isolation is required.** The standard CI cable is the 20 pin which provides limits and home sensor signals, access to the User Bit I/O lines, and VCC power & ground. Refer to Appendix A of this manual.

**Other Functions.** The Jog function (pin 6) is available at the Jog connector of the CI Cable; see Appendix A. External thumbwheel (pin 12) is not used. Instead refer to the I/O Path option for thumbwheel operation or stand-alone (PLC) mode. Note that the CW-CCW inputs are available in this system as the Emergency Stop option. Also, the Inhibit / Abort (pin 8) is not used in this system. This Abort is not the same as the driver abort (ABR).

**Reserved User Bits.**

- B 0 Enable Driver; must be LO to step. B0 LED will be ON.
- B 1 Bit 1 is always the Home Sensor.
- B 6 Bit 6 Is the Busy Bit (CTS). See mOde Command.

**LED Status Displays.**

OFF = Logic High or true ON = Low or false; pin # refers to CY 545 pinout.

- |  |                          |
|--|--------------------------|
| BZ Indicates the inverse of pin 27(User Bit 6)   | Off = Ready;On = Busy    |
| DR Indicates the polarity of pin 2 (direction)   | LO = CW                  |
| ST Indicates the polarity of pin 1 (step)        | LO = Step pulse          |
| PW Indicates the polarity of pin 3 (stop)        | LO = Stepping            |
| SW Indicates the polarity of pin 6 (slew)        | LO = Ramp speed          |
| B0 Indicates the polarity of pin 21 (User Bit 0) | LO = Enable all drivers  |
| B1 Indicates the polarity of pin 22 (User Bit 1) | LO = Home Sensor blocked |
| B2 Indicates the polarity of pin 23 (User Bit 2) | General Purpose User Bit |

**Reset.** To hardware reset or stop the system, cycle the AC power switch located on the rear panel.

**Software Configuration**

This system is a serial device directed by ASCII character commands. It is configured exactly as described in the Cybernetics controller manuals; except for differences as noted in this manual. Special Commands are created to simplify use of the Basic program.

### Reserved and Special Software Commands.

**CLEAR** Writes 0's and CR's to memory.

**LOAD [F6]** Loads memory. Not same function as Basic F3 key.

**EXIT [F5]** Required to close comm port, close file, and clear error traps.

**comma [,]** Do not use comma to separate elements of 545 commands (T,L, and ? M  
xx). Comma is a Basic symbol; use space instead.

**[a,b,c]** HP-LED command string is not used.

**C** Continuous Step Mode is normally not used with the CY545 unless to the  
motion can be terminated with an external Abort signal. Refer also selection of on-the-fly  
CY550 which is an advanced version which has a larger software commands.

### Special Aspects of Some Commands.

**W** The Wait command causes the 545 to wait at the instruction, therefore incoming stop commands will not be processed. Use a T command in a jump to itself.

**L, Z** These loop instructions assume that the first pass of a routine before reaching the loop command was the 1st loop pass. In general, the loop count must be one less than required. Also see J & T below.

**T,H,W,O** These commands are followed by a numeric value in Hexdecimal which is desinated by the H following the value. The decimal and the hex values for 0 to 7 are the same and the H can be omitted.

**H** Homing is a single step operation. The Busy signal is not continuously set during homing but cycles every step. It is best therefore that homing is executed from memory.

**J, T** Any Jump or Test operation, which includes L & Z commands, must not cross the memory page boundry which is ever 256 bytes; 256, 512, 768, 1024, etc. Use the Y for global jumps.

### Installation and Test Procedure

1. Connect AC power cord.
2. Connect motors, verify that driver current is correct for motors. See Appendix C for current adjustment and Appendix D for motor wiring.
3. Connect CI cable. Limit Loop must be closed for motor to run.
4. Connect the serial cable and turn-on computer system.
5. Connect the AC power and turn-on power switch or supplies. Verify that: AC neon; power is present. DC lamp; motor power (VMM) is OK. All SMC  
LEDs are off except for BUSY.

Refer to lines 500-1000 of the listings in this manual. These tests prove that the MMI system is operating correctly. Typically, a motor will run back and forth several times. Observe the LED indicator lights while the tests are running and note that each action of the system can be monitored and that this self-test is the series of commands listed between the quotes in lines 500-1000. All actions of the system are the result of COMMANDS, refer to the back cover of the CY 545 manual, either stored in the external memory (Memory Mode) or sent from the host computer (Direct Mode). The third mode (Programming Mode) is when commands are sent from the host and written into the external memory.

### Computer Test Procedure

1. LOAD and RUN the Demo program which will down-load self-tests. Refer to lines 500-1000 of the listings.

2. Verify the time delay is correct for the host computer. During testing, the system will return the network status characters or other query information; R0FO (status) or P=000000 (position) for example. If the returns are in segments: P=

00  
00

with multiple line feeds between characters, the host computer is too fast for the comm card. Exit the program (F5), refer to line 120, and increase the timebase (T value) for the host computer. Re-start (shift-F5) the program.

Note the serial delay routine (GOSUB 2500) at Line 2500 is multiplied by itself; use small increases. When set correctly, the display will have no vertical segments but also have no excessive delay in responding to queries.

NOTE: If the message "system is busy or not connected....." appears, enter Ctrl-Break. The system IS NOT connected to COMM 1. RESET the MMI and correct the serial cabling.

The MMI system should, when the MMIDEMO.bas is run, lite B 0 (motors enabled), lite DIR (direction = +), BUSY lite off, and return status (none busy) to the display.

### 3. Motor Commands.

NOTE: Enter the following commands (Direct Mode) at the prompt. Motor E of SR4 #0 is default (Enter Command>W0E. Symbols used below are: < = Enter key, Fx = function key.

F9	the SMC returns position; this indicates communication is OK
p 2000<	motor will move to position 2000 ( 2000 steps CW )
F9	? P returns P=0002000; position is 2000
p 0<	motor returns to position 0
b 0<	free motor E; B 0 LED is out

#### 4. Memory Commands.

F7 ? y where y is memory byte pointer; y=00000 after reset.  
y 0< sets pointer to byte location 0; if required.  
? m 21< displays 21 "command lines" of memory (F8 and type 21<).  
CLEAR< fill the memory with 0's and carriage returns; STOP commands.  
YES< yes; wait till 0 0 0 0....DONE.  
F7 y=0000.  
F8 21< memory is cleared; all zeros and carriage returns; 42 bytes.  
F6 load memory; host goes to line 1000; returns ? p when done.  
F7 y=xxxx; last byte of program.  
y 0< set memory byte pointer to byte 0.  
F8 21< memory is loaded.

x< sample motor test program in memory will run; note that memory  
query (F8 21<) did not move the memory address pointer (y=0000).  
F7 last address of program; pointer did move with each line of program.  
y 0< reset to top of program.  
x< sample motor test program in memory will run.

ADW0D< change SMC address; prompt is now W0D<:.

Repeat the above with motor # 2, for example.

Parameters. Refer to the CY 545 MANUAL, SECTIONS 1-12 (Commands), 16 (see StepMotor and Home), 17 (Rate Tables), 19 (good sample program); sections 13,14,15 not used. Typical commands will duplicate the down-load with different values of R, S, and F used in order to determine the best parameters for moving the motor. Refer to the Rate Tables. Repeat Step 3 with different parameters.

Resonance. Resonance (feed-back oscillation between the motor rotor and the motor coils) is a vibration which affects the motor behavior. Typical symptoms are shuttering, dropping steps, jumping back and forth, hard running, and excessive noise (unpleasant). All step motors exhibit resonance at approximately 100 full step/sec (Low Frequency) and at 1000 full steps/sec (Mid Frequency). This behavior is affected by motor load, power, and speed. The normal procedure is to start at a speed (F command) above the low point and ramp through the mid point (S command) to a higher speed (R command).

To determine the resonance points, set F and S to the lowest value and R above mid freq. Move the motor sufficient steps to reach top speed. Note the points during this acceleration where the motor exhibits abnormal behavior; these are the low frequency nodes. The motor will stall at the mid freq. point. Resonance can be reduced by less power, decoupling the motor and load (isolating couplers; not metal to metal), higher speeds, faster acceleration, and/or smaller step angles.

## **Programming**

The software program used with the MMI/SR4/SMC system is only a "Serial Driver" routine. The main purpose of the program is to send and receive commands between the host and the MMI microprocessors. The motion control software (firmware command set) is contained only in the CY545. The QBASIC serial driver contain examples of typical operations required by the host computer software, such as: opening the comm (serial) port, sending/receiving characters, loading the 545 memory, handling the Busy status, and diagnostic capability. Included in the sample program are routines of 545 commands which exercise the motion system during manufacturing tests. Two types of routines are demonstrated; (1) downloading a string of commands from a keyboard file and (2) loading a string of commands to EEprom memory.

**The sample listing is commented and contains information about how to operate a 545 system. It is helpful to "read the listing" even for non-computer types.**

Line 0-20 defines the variables and create symbols for control characters.

Line 30-100 assigns the Basic function keys for common functions.

Line 120 creates the time delay used between characters so that fast computers do not get ahead of the serial card and the MMI.

Line 130 defines the serial port as the ACTIVE device; PRINT #ACTIVE sends characters to the active port.

Line 200-400 creates the introduction screen display

Line 500-999 is the down-load test routine which is sent to the 545 when this program is first run.

Line 1010-1410 is the Self-Test program. The GOSUB 2500 is the time delay for the write cycle of the EEprom memory.

Line 1500-1800 is a sample homing routine with a limited number of re-tries; loop counter, input test, and message transmission are demonstrated in this program.



**Line 2000-2510 assembles keyboard entries and sends them to the MMI at the Enter key ( CR = carriage return or enter key). Note the special commands at line 2210-2270 which are created commands not part of the MMI command set.**

**Line 2600-2750 reads any incoming characters from the MMI and prints to the host display screen.**

**Line 2910-3000 closes the comm ports on Exit (F5) or a computer error code other than ERROR = 24 (comm port is busy).**

**Line 3000-3150 writes zeros (545 stop command) and carriage returns over the entire memory (Clear command) which erases the memory. The opposite is the Load command which writes the memory.**

**Line 3300-3400 is the busy error routine.**

**Line 4000- are the help files.**

**Program Listings**  
**See MMIDEMO program**

## Serial Cables

<u>XT TYPE.</u>	CPU DB-25 (IBM STYLE)	CONTROLLER DB-9S (AT)
PIN 1	Frame Ground	<-----> Shell (solder)
PIN 2	TX Transmit	-----> PIN 3 RX Receive
PIN 3	RX Receive	<----- PIN 2 TX Transmit
PIN 5	CTS Clear	<----- PIN 8 DSR Ready
PIN 7	Signal Ground	<-----> PIN 5 Signal & Frame

DB-25 to DB-9 Adaptor

<u>AT TYPE.</u>	CPU DB-9P (IBM STYLE)	CONTROLLER DB-9S (AT)
<u>Note : DB-9 Controller is wired as a Null Modem ( pin to pin )</u>		

PIN 3	TX Transmit	-----> PIN 3 RX Receive
PIN 2	RX Receive	<----- PIN 2 TX Transmit
PIN 8	CTS Clear	<----- PIN 8 DSR Ready
PIN 5	Signal Ground	<-----> PIN 5 Signal & Frame
PIN 4	DTR Ready	-----> PIN 4 DTR Ready
Shell	Frame Ground	<-----> Shell Signal & Frame

pin to pin cable

<u>MAC DIN.</u>	CPU DIN-8 (EIA-422)	CONTROLLER DB-9S (AT)
PIN 5	RX In-	<----- PIN 2 TX Transmit
PIN 3	TX Out-	-----> PIN 3 RX Receive
PIN 2	CTS Hand In	<----- PIN 8 DSR Ready
PIN 4	Signal Ground	<-----> PIN 5 Signal & Frame
PIN 8	RX In+	<-----'
PIN 1	DTR	-----> PIN 4 DTR
Shell	Frame Ground	<-----> Shell Signal & Frame

MAC to IBM Adaptor Cable

The Controller/Device signal DSR (Data Set Ready) is wired to the network CY233 status input CTS (Cleared To Send). When the controller is busy, the DRS will set HI or or busy and pull CTS HI or not Clear To Send. The host CPU should not send when the device is busy. See Status Code Table.

If the host software ignores the CTS status signal and commands are sent to a busy motion controller, the commands will be lost or jam the controller. Typical indications of the host failing to obey the CTS are: motion or homing stops when host program is run, motor runs backwards at high speed forever, or only part of a memory routine is completed.

It is the responsibility of the host software to check status for "not busy" before sending commands to the selected device.

## SECTION 4: MMI

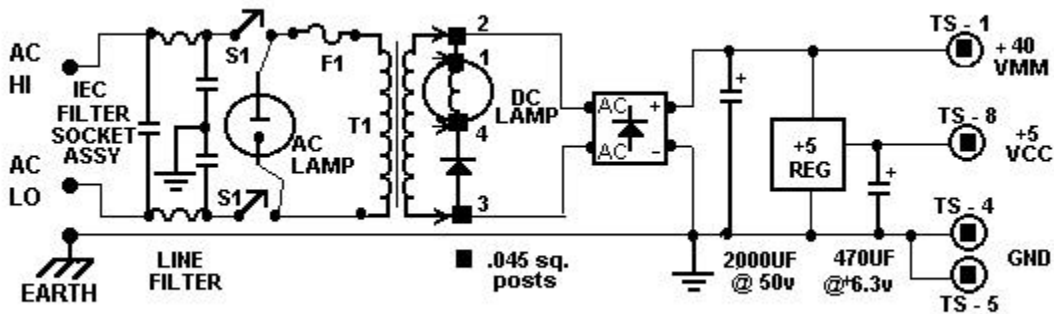
### Mechanical Assembly

The MMI assembly consists of the SR4 network controllers, the SMC (CY 5.4 controller & MS 2.0) motor drivers, all DC power supplies, and an AC power entry. The DC power supplies provide +5 vdc TTL computer (VCC) and +40 vdc motor (VMM). The VCC supply is over-current protected. In addition, A 1 amp AC fuse protects the entire assembly.

**NOTE: NEVER REPLACE THE FUSE.  
FUSE FAILURE INDICATES DRIVER FAILURE.**

The green chassis lamp indicates VMM (motor) power on. The neon lamp in the power switch indicates that AC power is present to the MMI. The MMI has six pin motor connectors (see Appendix D), IEC power connector, network serial connectors (refer to serial cable section), and LED status indicators. The 20 pin CI cable connectors provides access to the spare I/O lines, limit loop, home sensor and VCC power/ground. Refer to Appendix A.

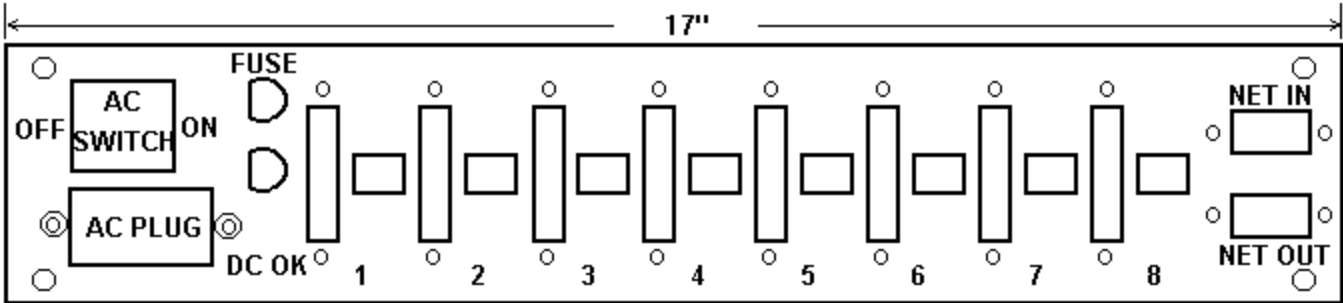
POWER SUPPLY WIRING DIAGRAM



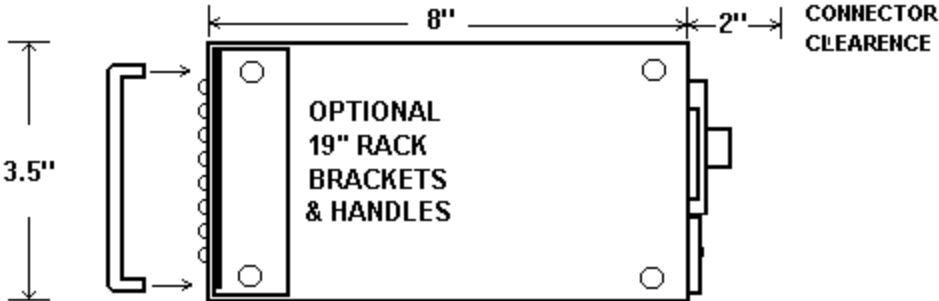
**NOTE: NEVER REPLACE FUSE! FAILURE INDICATES DRIVER DAMAGE!**

19" RACK MOUNT OR FREE STANDING ASSEMBLY (17" WIDE X 3.5" HIGH X 8" DEEP)

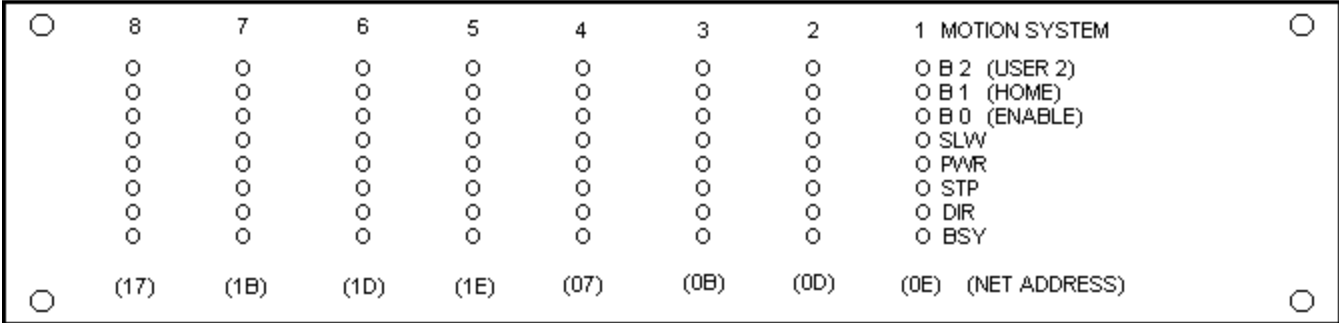
BACK PANEL (REAR VIEW)



SIDE PANEL (END VIEW)



FRONT PANEL (FRONT VIEW)



# MS

MS - MiniStep translator /driver card

**OPERATION AND INSTALLATION**

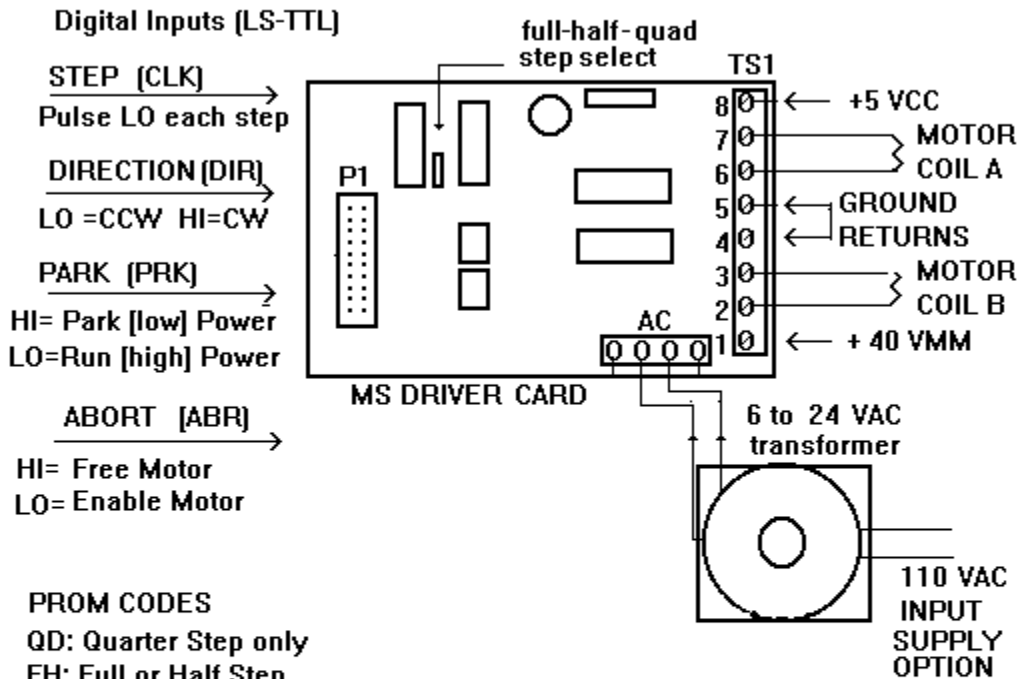
**MANUAL**

**FOR MS SERIES**



PO BOX 4585 MOUNTAIN VIEW, CA 94040 TEL: 415-969-5829 FAX: 415-968-6192

## MS 2.0 STEP MOTOR TRANSLATOR/DRIVER 2 AMPS PER COIL IN FULL, HALF, OR QUAD STEP



See Appendix A for P1 connector  
 See Appendix B for Limit Loop  
 See Appendix C for Current Adjustment  
 See Appendix D for Motor connection  
 See Appendix E for Mechanical Card  
 See Appendix F for Home Sensor  
 See Appendix G for Opto Isolation Option  
 See Appendix H for AC Input Option

**POWER SUPPLY REQUIREMENTS:**

VCC = + 5 vdc TTL Logic  
 @ 100 ma

VMM = + 5 to 40 vdc  
 @ 10 to 2000 ma

**PRODUCT DESCRIPTION.** The MM & MS, Series 1 & 2, stepper motor driver, is a switching type, constant-current regulator which drives current pulses through the windings of a stepper motor. All stepper motors are stepped or rotated by changing the direction of the current flow through the windings in a unique sequence. Each change of current direction results in a step.

The driver contains two sections: (1) the step generator; and the (2) power drivers. The step generator is a digital logic system which receives input commands from a controller (typically a microprocessor) and generates a series of step signals. The power drivers receive the step signals and switch the phase of current in the motor windings.

The driver requires a minimum of four input signals: (1) the step pulse - STP, (2) the direction level - DIR, (3) the power level - PRK, and the enable signal - ABR. The step pulse (or step clock) to the input of the driver will cause a corresponding change of the output current resulting in one step (one unit of motor rotation). The direction input is a digital level signal which controls the direction of motor rotation. If the signal is true (Hgh), the motor rotates in CW direction; if the signal is false (LOW), the motor rotates in CCW direction. In addition to the step and direction inputs, the driver will accept an output power control input. This digital input, PARK, controls the amount of current delivered to the motor windings either run power or park power. If the signal is HI or floating, the driver is at reduced current; if LO the driver is at full current. The enable signal, ABoRt, sets the current to either off or on. If the signal is HI or floating, the driver is FREE (no current); if LO, the driver is enabled.

In addition to the digital input signals, the MS driver also requires a power supply input of unregulated D.C. voltage. The driver functions to control the current furnished by the D.C. supply. The combination of a D.C. supply and the MS driver is referred to as a current-regulated power supply, or constant-current motor driver. The driver regulates the current through the motor winding by rapidly switching on and off the D.C. voltage. This technique is referred to as switch-mode or chopper stabilized regulation. The driver also requires +5 TTL logic supply for the digital sections.

**OPERATIONAL MODES.** The driver can be operated in three modes: FULL-step or HALF-step, and QUAD-step only. In each of these modes, the output power control, PRK, is controlled by an external microprocessor. PRK is used to reduce driver and motor heating during non-step periods.

**THEORY OF OPERATION.** The unique element in the driver is the current regulator device, referred to as the "driver chip". This driver has three main inputs: (1) the phase-control, F; (2) current-control, I0; (3) current-control, I1. The outputs of a driver are the connections to a single motor winding. Internally an output section contains four power transistors configured in an H-bridge with two pair sourcing current and two pair sinking current. The motor winding is connected across the bridge. If one source transistor (at one end of the winding) and one sink transistor (at the other end) are turned on, then current flows through the winding. Alternately, if the other pair is on, then the current will flow through the windings in the opposite direction. The D.C. Supply is connected to the top (positive) and bottom (negative) of the H-bridge transistor pairs. An external resistor (typically 1 ohm or less) is inserted in series between the negative of the H-bridge and the negative of the power supply negative so that the total winding current flows through the resistor. When full winding current flows, the small voltage (400 mv) across the resistor is fed back to the comparator section and turns off the H-bridge transistors. After a fixed-time off to allow the transistors to settle and the feed-back voltage to dissipate, the bridge again turns on and current builds up in the winding until the voltage across the sense-resistor again trips the comparator.



The digital phase-input (F) level (HI or LO) selects which pair turns on and corresponds to the direction of current flow through the winding. The current controls, (I0 and I1) select one of four comparators; zero, low, medium, or full. The output is therefore a series of current pulses equal in amplitude and separated by the period of fixed time off. The value of the current sense resistor is pre-selected to produce a current amplitude equal to that of the current rating of the motor winding. If I0 and I1 select a comparator other than FULL, then the sense resistor feed-back voltage trips at less than full current. The reference voltage of the comparators is also available as an input to the device. By externally controlling this reference input, the output current can be varied between zero and full (i.e. microstepping).

The driver card contains three sections: (1) the step generator, which controls the digital levels of the phase (F) inputs; (2) the drivers; and (3) the Auto-Park gate, which if installed, controls the output-current digital input, PRK, automatically. The step generator is a counter-PROM configured as a four-eight- sixteen step counter. The outputs of the counter are combined through PROM gates into two outputs which control the phase inputs (F) of the two driver IC's. Each step-clock causes the step counter to toggle one step and the PROM decodes a pair of phase commands to the drivers which cause a winding current direction change resulting in a one step rotation of the motor. The direction input, input directly to the counter, directs the decode to produce a CW or CCW rotation.

**INSTALLATION AND OPERATION.** Before operating the MS & MM series, that the input connections are correct for that mode. Refer to the installation wiring diagrams found in the back of this manual. Locations of jumpers and signals are identified on the bottom SMCe of the unit circuit board. The configuration of the MS series requires attention to four areas: step size jumper and PROM type, power supply voltage, motor winding connection, and current control dial-pot setting. Refer to driver label for maximum current and voltage limits of the particular model. Refer to the Appendix section in the rear of this manual for details.

#### (1) POWER SUPPLY & MOTOR CONNECTIONS

Signal Name	Terminal Strip	TS1	Data Connector	P1
-------------	----------------	-----	----------------	----

VMM	TS1-1	none		
-----	-------	------	--	--

In general, the MS series requires an unregulated source of D.C. voltage connected to VMM. The current output must equal 1.414 the full rating of one motor winding. The voltage can be between 12 and 45 volts D.C. (maximum). The higher voltage is required only for higher step rates. In general, do not use a regulated power supply as performance is reduced. Refer to the unit label for the VMM maximum of that model.

VCC	TS1-8	P1-13 & 14, 1, 6		
-----	-------	------------------	--	--

If the optional +5vdc TTL supply is not installed, then an external 150ma digital supply is connected to the TS1-8 VCC connections. TS1-5 is provided for ground return. TS1-8 is protected by a 6.8vdc TRANSORB. The VCC is ALSO common through the digital control connector P1-13 & 14. The +5vdc can be furnished by: (1) the computer or controller power supply only, or both. If the system power is not controlled by one switch, always isolate the driver systems with a diode in the VCC connection. In any case, controller VCC and driver VCC MUST BE COMMON or other interface connections are required (opto isolation).



**Spare Inputs** P1- 18, 8 & P1- 20, 7

Pins 18 and 20 can be used for other signals to/from the card. See Chassis Signals connector. Pin 20 is normally keyed on free standing cards.

**(3) Chassis Signals** P1- 1 to 9 & P1- 2 to 10

These signals are normally used to provide for a convenient method of cabling the driver between the controller and the motor, power supply, chassis assemblies.

**Home Sensor Pins** P1- 1, 2, 3, 4

These pins power the optical home sensor circuit. SEE APPENDIX A & F. Pin 1 is VCC +5 power, pin 2 is VLED power, pin 3 is GND (ground), and pin 4 is the HOME input from the sensor.

**Abort Loop Pins** P1- 9 & P1- 10/12

These pins normally constitute the ABORt Loop Safety (limits) System. The driver enable is output from the controller to pin 12 (CPU ABR) and output to the loop from pin 10 (to limit loop) and returned from the loop to pin 9 (ABR). The ABR loop is NORMALLY CLOSED; opening the loop for any reason FREES the motors. Never connect these signals to any potential or device except passive switches or relays. Door locks and other safety switches may be inserted in the loop. See Appendix B.

**Spare Pins** P1- 6, 5, 7, 8

These pins are used as required to provide VCC (pin 6) and GND (pin 5) to the chassis system. Pins 7 and 8 are user pins which are generally jumped as required to the spare pins on the data connector. See Appendix A.

**(4) FULL/HALF/QUARTER STEP SELECT**

This series will operate either in FULL/HALF step or QUARTER step only mode. FULL/HALF requires the FH PROM to be installed and the mode pin to be jumped either FULL or HALF with a dip-clip jumper. The jumper pins are located next to the top of the PROM socket. See Appendix F.

In QUAD step mode, the QD PROM is installed and the mode pin is jumped to the QUAD pin. Conversion is a field operation.

The PROMS are also labeled with the current control selection.

HL: shifts power HIGH (100%) to LOW (25%) during parking.

HM: shifts power HIGH (100%) to MED (60%) during parking.

**(5) CURRENT CONTROL DIAL**

The current dial sets the 100% power level of the driver outputs as required. Refer to App C.

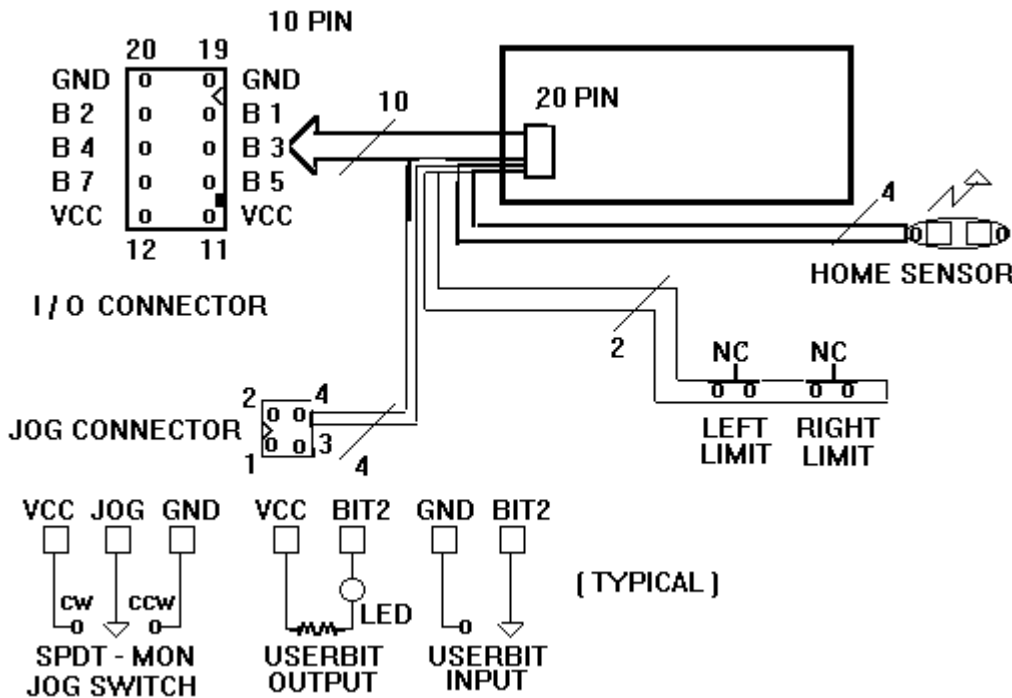
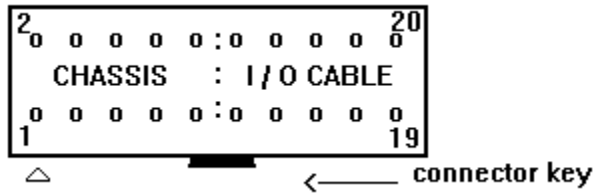
## APPENDIX SECTION

APPENDIX A: CI CABLE DIAGRAM FOR MMI SYSTEMS

COLOR   = MOLEX PIN #

1: SENSOR +5 VCC	BLK <span style="border: 1px solid black; padding: 0 2px;">1</span>	2: SENSOR LED ANODE +	WHT <span style="border: 1px solid black; padding: 0 2px;">2</span>
3: SENSOR / LED GND	GRY <span style="border: 1px solid black; padding: 0 2px;">3</span>	4: SENSOR OUTPUT	PUR <span style="border: 1px solid black; padding: 0 2px;">4</span>
5: USER GROUND	BLU <span style="border: 1px solid black; padding: 0 2px;">1</span>	6: USER + 5 VCC	GRN <span style="border: 1px solid black; padding: 0 2px;">2</span>
7: JOG SWITCH IN	YEL <span style="border: 1px solid black; padding: 0 2px;">3</span>	8: USER BIT 2	ORN <span style="border: 1px solid black; padding: 0 2px;">4</span>
9: LIMIT LOOP IN	RED <span style="border: 1px solid black; padding: 0 2px;">1</span>	10: LIMIT LOOP OUT	BRN <span style="border: 1px solid black; padding: 0 2px;">2</span>
11: USER +5 VCC	BLK	12: USER +5 VCC	WHT
13: BIT 5	GRY	14: BIT 7	PUR
15: BIT 3	BLU	16: BIT 4	GRN
17: BIT 1 [same as 4]	YEL	18: BIT 2 [same as 8]	ORN
19: USER GROUND	RED	20: USER GROUND	BRN

CI CABLE  
20 PIN CONNECTOR



**HOMING.** A major advantage of a digital Open-Loop step system is the ability to operate plus or minus zero steps (no error). Two conditions are required. One is that the motor is sufficient for the load in normal operation and second, that a reference position, commonly called the "home position", be consistently established during initialization of the system. When step motors are rotated by counting (clocking) out a number of steps, in theory, the motion will take place +/- zero steps. The exact mechanical position of the motor can vary by the motor step accuracy; typically +/- 3 % of one step (non-cumulative). A proof of +/- zero step operation is, first, to reference a starting position of the motor or "home". During homing, the motor is stepped backwards into a switch, reversed, and then stepped forward until the switch opens. The point of interest is not the exact mechanical position but rather on which step the switch changed state. For that reason, only high resolution "PHOTO-LOGIC" optical-beam switches are used in TMG systems.

**SLIP-DETECTION.** After the motor is home, the controller position counter is reset to the home position, typically position 1 (one step out of the sensor). The motor is then stepped CW to any position. To slip-detect the system, the motor is returned to position 1. If the sensor remains open, then the motor is stepped to position 0. If the sensor closes, the system is operating +/- zero steps (error free). Note that a single step lost (slip) will always result in at least a movement of 4 full steps away from the correct position. Open loop systems are slip-detected at regular intervals to prove continuing slip-free operation.

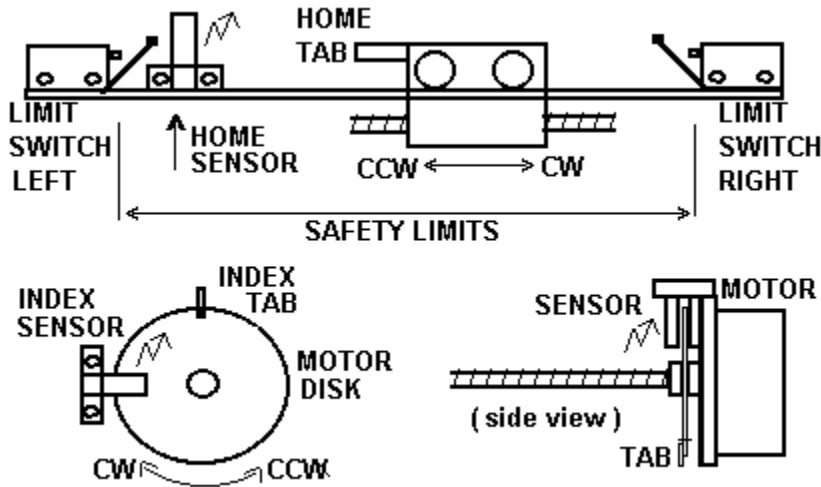
**CENTER HOME AND CONTIGUOUS SLIP DETECTION.** If the home sensor is located at the center of axis motion and a step bar is mounted along the entire motion path, then the home position can be verified each time the system crosses the center line. A stepped bar is thin strip with a left high SMCe and a right low SMCe. The high to low edge is the center line.

**LASH COMPENSATION.** A major advantage of steppers is in their "repeatability" which is typically less than .01 % because the digital controls are not affected by temperature, aging, voltage or adjustment. This allows errors such as lash and distortion to be zeroed-out.

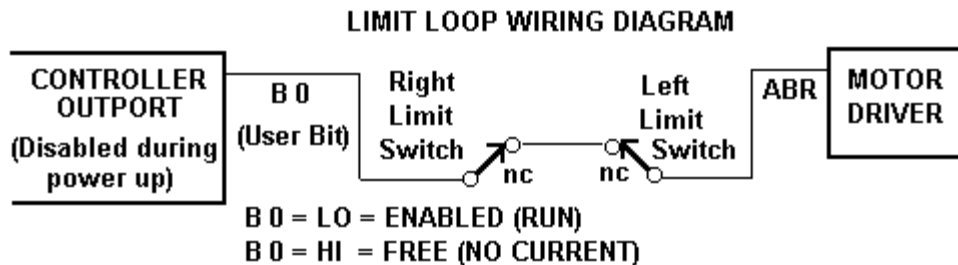
Lash compensation adds or subtracts steps, at each change of direction or because of other forces, to take-up the lash error. Lash compensation is accomplished during the slip-detection process. When the system is slip-detected the first time, the sensor will not close at position 0 because of the lash; home LED remains off. At this point, the system is single-stepped CCW until the sensor closes; home LED is on. The number of CCW steps is the lash compensation value. The system is re-homed and the counter loaded with this value (see At home command). The motor is then moved some number of steps CW, returned to position 1 (sensor open), and finally position 0 (sensor closed). The system is +/- zero steps.

Screw distortion error occurs when the screw pitch, which is so many turns per inch, does not move the correct distance after the correct number of turns of the motor. For example, a 10 turn screw should cause linear travel of 1 inch every 2000 steps (200 step/rev motor). If, rather than commanding the motor controller to go in 2000 step increments, the controller moves to absolute positions such as 2000, 4001, 6003, 7999, ect.; the error is eliminated. This technique requires a control system which carries a "map" with each individual machine. The EEPROM memory is suitable for this purpose.

**SUPER HOMING.** In high resolution systems, two sensors are used. The first sensor, the home sensor, is mounted to the motion platform in the typical configuration. The second sensor, the index sensor, is located as an index detector on the motor shaft. The index can be either a disk with a tab or a long pin. During the homing operation, the motor is stepped backwards until the first sensor is blocked. The motor, however, continues to rotate until the second or index mark is detected. The system is now "homed to the step". TMG systems with Super-Homing use two identical "PHOTO-LOGIC" sensors wire-ORed together so that both must be blocked before the home signal is detected. The H or home command of the motion controller will operate with either single or double sensors.



**ABORT LOOP FUNCTION.** In TMG systems, the ABORT loop is used to remove all winding power to the motor during an out-of-bounds condition. The ABORT feature can be used to provide hard-limits, emergency stop, door interlocks, and other safety features. As the ABR input, to the driver, must be LO (ground) for the driver to step; opening the loop will stop (free) the motor regardless of the control logic. The diagram is typical of TMG "Fail-Safe, Hard-Soft" limit loops.



**NOTE: CONTRARY TO POPULAR PRACTICE, IT IS UNWISE AND UNSAFE TO SENSE LIMITS AND OTHER SAFETY CONDITIONS THROUGH THE COMPUTER INPUTS PORTS.**

All motion products, regardless of their final intended form, should initially incorporate home sensors and slip-detection in order to prove correct positioning during product development, particularly during software de-bugging. Typically, a test routine is established which passes slip-detection. Any detrimental modification or code flaw will be flagged by this routine.

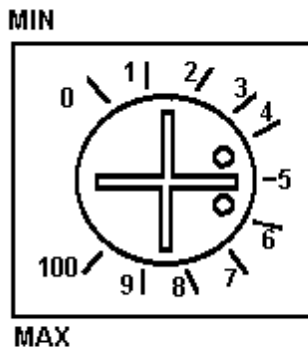
**APPENDIX C: MOTOR CURRENT ADJUSTMENT MM 2.0 (2 AMP MAX) SERIES**

**TO SET CURRENT; ALIGN SLOT TO MARK; CAREFULLY.  
 POT ADJUSTS PERCENTAGE OF MAX POWER. 2 AMP x 50 % = 1 AMP /COIL**

**IN GENERAL:**

- CURRENT TOO LOW; MOTOR SLIP FROM REDUCED TORQUE**
- CURRENT CORRECT; SMOOTH ROTATION WITH NO SLIP OR RESONANCE**
- CURRENT TOO HIGH; EXCESSIVE NOISE, SLIP, MOTOR OVERHEATING (ABOVE 85 C), AND POOR RAMP PERFORMANCE**

BOARD EDGE  
 →  
 →  
 PERCENTAGE OF  
 MAXIMUM POWER



**NOTE:**  
 DRIVER WILL REDUCE  
 CURRENT IF OPERATED  
 CONTINUOUSLY AT SLOW  
 RATES (200 PPS) WITH  
 CURRENT SET ABOVE 60 %.

**WARNING: CONSTANT CURRENT, AUTO-PARKING, BI-POLAR DRIVERS !  
 DO NOT ATTEMPT TO MEASURE CURRENT WITHOUT SPECIAL INSTRUCTION**



Performance of a stepper motor based system depends more on the electronic drivers used than it does on the motor itself. A step motor (both PM and Hybrid type) is made to step by sequencing the orientations of the magnetic fields in two coils. The UNIPOLAR drive method of is illustrated, in the figure, using just ONE coil of the motor. Note that the center tap of the coil is connected to the positive motor supply voltage. An electronic circuit, represented by the switch, then connects one end or the other to ground for current to flow from the center tap to the grounded end. The most significant factor is that only one-half of the coil is used at any given time and that the magnetic field intensity (motor torque) is proportional to the product of the number of turns in the coil and the current passing through the coil.

Motors designed for BIPOLAR drivers will often have only four leads. However some manufactures will provide the motors in 8 wire versions to offer a performance choice for bipolar drive users as in figures C & D. Four lead bipolar motors may use larger wire, since only half the windings are required in the given space of the motor body. The paralleling in figure C is the equivalent of this to achieve lower winding resistance and thereby doubling motor efficiency. The other alternative for the motor designers is to use a greater number of turns in the winding space. This is shown by figures B & D and results in more torque with a lower coil current but a subsequent loss of high speed torque.

Although step motors are often classified as bipolar or unipolar (2 phase or 4 phase), these terms are more accurately applied to the types of electronic circuit used to drive the motor. Bipolar drivers can drive 4,5,6 and 8 wire motors. When the motor is described as unipolar, the specifications are presented with the assumption that the motor will be driven with a unipolar drive. Therefore the specifications must be translated to bipolar when the motor is used with a bipolar driver. In general, the translation is similar to a unipolar driver with dropping resistors in series with the center taps; referred to as  $L$  over  $xR$  with  $R$  equal to the motor winding resistance. For example, a  $L$  over  $4R$  unipolar driver has a resistor equal to 4 times the winding resistance. In bipolar, the  $L$  over  $R$  ratio is the ratio of the motor voltage to the supply voltage. A  $L$  over  $4R$  bipolar drive, for example, would be a 6 volt motor and a 24 volt power supply. Performance would be similar to the  $L/4R$  torque curve of a unipolar motor. The figures identify the various connection options when using a bipolar driver with 6 or 8 wire motors.

**A: SINGLE COILS.** Identical to unipolar specification (if the supply voltage equals the specified motor voltage). Normal connection of a bipolar driver to 6 wire motor.

**B & D: SERIES COILS.** This configuration will produce torque greater than the unipolar specification indicates. To stay within the power (wattage) rating of the motor, reduce the unipolar specified current by 30%; depending on the duty-cycle of the system (park time). Note that the torque curve of this configuration is considerably fore-shortened as this motor is now the same as a motor with a rating of twice the voltage (slower motor).

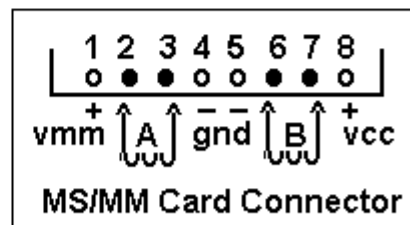
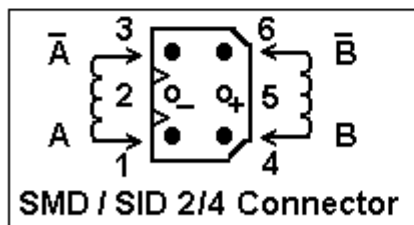
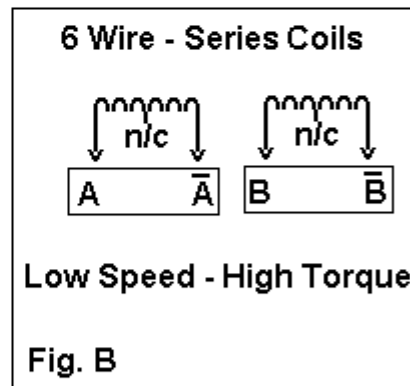
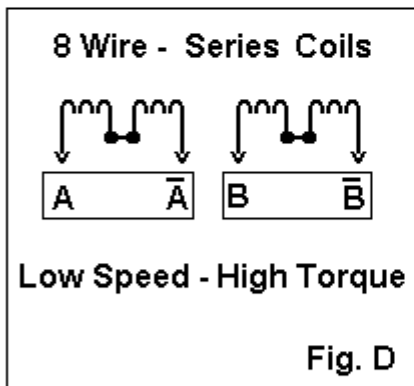
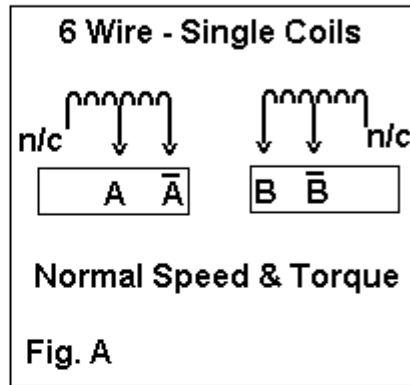
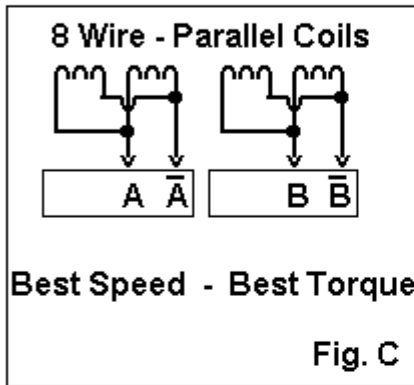
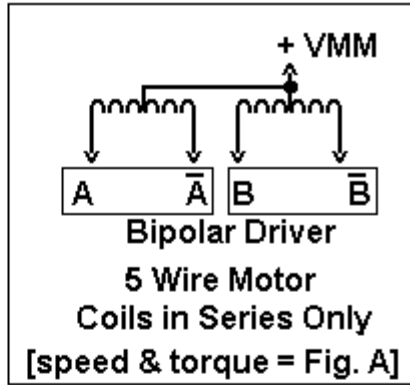
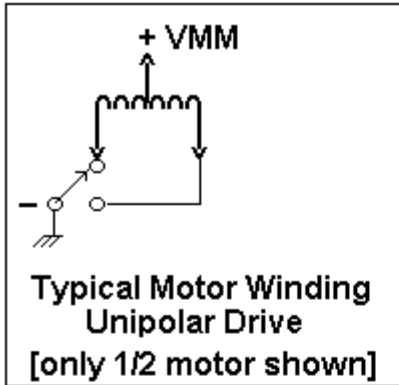
**C: PARALLEL COILS.** When this configuration is driven at the unipolar current, the motor will perform identical to the specification but the motor will dissipate only one-half the power (it is twice as efficient). When the current is increased by 1.414, to drive the motor at it's full power rating, the motor torque is increased by approximately 60% Note that this torque curve is extended by four times (high speed system).

Resonance (vibration) of a step motion system depends on the speed and power range of the motor. Fast windings (A & C) are "quicker" and may break into resonance easier than slow (B & D). Power windings (B & D) may deliver "excessive" power (torque) to the system and produce resonance. In general, resonance indicates, except at the low (100 sps) and mid-frequency (1000 sps) bands, excessive power; therefore reduce the driver current for smoother operation or wire the motor for "softer" response.

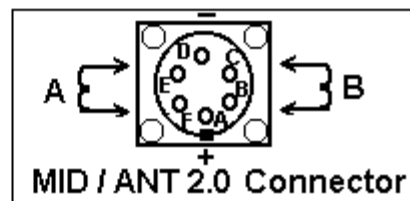
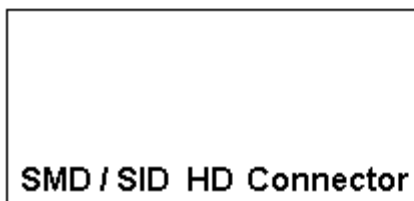
**NOTES:** If a motor runs "backwards" with respect to software direction, transpose the connections of ONE coil. For MS series driver cards, pins 2 & 3 or 6 & 7; SMC / MMI driver boxes, pins 1 & 3 or 5 & 6.

Five wire motors are really 6 wire motors with the center tap common. The center tap must be connected to the motor supply voltage. If phases 1, 2, 3 or 4 are crossed, motor will not rotate (hums). For MS cards, pin 1 is VMM, for SMC /MMI (if connected), pin 5 is VMM and pin 2 is GND.

Systems with pin 5 & 2 connected are used to power external relays or solenoid valves. The pins are keyed (reversed). Never attempt to connect any motor leads to pin 2 and only 5 wire center taps to pin 5. Pins 2 & 5 are normally not connected and used to store the unused leads of 6 or 8 wire motors.



**MOTION GROUP MOTOR CONNECTORS**











**MOLEX - WALDOM NYLON CONNECTOR SYSTEM USED BY THE MOTION GROUP**

The connectors used on Motion Group equipment are nylon connectors are manufactured by Molex and are referred to as .062 style (pin diameter) or .093 (large driver motors only). They are available from Newark, Allied, and Digi-Key and come in 1 to 36 positions with locking and mounting tabs which snap-in to punched holes on brackets or enclosures.

TYPICAL \$	POLES	TYPE	PART #	NEWARK #	USED ON
5.84/10	4 (.062)	MALE HOOD	03-06-2041	31F1004	HOME SENSOR ASSEMBLY
5.95/10	4 (.062)	FEMALE RECT	03-06-1041	31F1005	HOME SENSOR CABLE
1.86/5	6 (.062)	MALE HOOD	03-06-2062	31F1008	STEP MOTOR ASSY
2.07/5	6 (.062)	FEMALE RECT	03-06-1061	31F1009	MOTOR OUTPUT
1.86/5	6 (.093)	MALE HOOD	03-06-2062	31F1008	STEP MOTOR ASSY
2.07/5	6 (.093)	FEMALE RECT	03-06-1061	31F1009	MOTOR OUTPUT

(Strain Relief Hoods are available on request)

Contacts for Connector Sets .062 SIZE

6.79	FEMALE SOCKETS	LARGE TAB	02-06-1103	31F1027	22-18 GAUGE WIRE
	MALE PINS	LARGE TAB	02-06-2103	31F1026	22-18 GAUGE WIRE
	FEMALE SOCKETS	SMALL TAB	02-06-1132	31F1029	30-22 GAUGE WIRE
	MALE PINS	SMALL TAB	02-06-2132	31F1028	30-22 GAUGE WIRE

Contacts for Connector Sets .093 SIZE

6.79	FEMALE SOCKETS	LARGE TAB	02-06-1103	31F1027	22-18 GAUGE WIRE
	MALE PINS	LARGE TAB	02-06-2103	31F1026	22-18 GAUGE WIRE
	FEMALE SOCKETS	SMALL TAB	02-06-1132	31F1029	30-22 GAUGE WIRE
	MALE PINS	SMALL TAB	02-06-2132	31F1028	30-22 GAUGE WIRE

In general, single wires use small tab contact; double wires the large tab

Tooling

105	RATCHET TOOL .062 DIA	HTR-2262	11-01-006	30F338	MAKES PERFECT CRIMPS
105	RATCHET TOOL .093 DIA	HTR-XXXX	11-01-006	30F338	MAKES PERFECT CRIMPS
13	HAND TOOL	HT-1921	11-01-0015	31F1049	REQUIRES PRACTICE
12	EXTRACTOR .062 DIA	HT-2285	11-03-0002	30F773	SPRING LOADED PUNCH-OUT
12	EXTRACTOR .093 DIA				

Nylon Connector Designer/Service Kit

Contains male/female housing assortment, hand crimper, pin extractor (not as easy to use as spring extractor; see above), contacts, and case.

40	DESIGNER KIT	.062	WM-072	30F774	
40	DESIGNER KIT	.093			

All of the above, including custom cable sets are available from the factory.

Note: When disconnecting, grasp the mounting tabs, (not the wires) and rock from top to bottom (unseat the locking bump) rather than SMCe to SMCe and then pull the connection apart. The connections unseat easily with the right technique.

Contact factory for Heavy Duty Connectors with Metal Shells, Retainers, and Strain-Reliefs.

## SPECIFICATIONS - MMI

PARAMETER	MIN	MAX	UNIT
Power			
Motor supply voltage	12	40	VDC
Current (no motor)	150	160	ma
PWM frequency			
MD10A	18	24	Khz
Motor current			
MS2.0	0.05	2.0	Amp
Step pulse input			
Voltage	0	+5.0	VDC
Sink current	12	20	ma
Pulse high	1		uSec
Pulse low	1		uSec
Rise time		0.5	uSec
Fall time		0.5	uSec
Frequency		500	KHz
Logic '1' volts	+1.8	+2.0	VDC
Direction input			
Voltage	0	+5.0	VDC
Sink current	12	20	ma
Logic '1' volts	+1.8	+2.0	VDC

Note: The step pulse input must be a logic 1 (high) during direction input change.

Environmental			
Operating temperature	-20	+50	C
Humidity (non-condensing)	0	95	%
Shock	100		G
Altitude	30.000		FT
Mechanical			
Weight	3		lb
Dimensions	2" x 3.5" x 11.0"		
Mounting hole centers	2.625" x 8.250"		
Mounting screw size	#6-32 x 1/2" max		



**THE MOTION GROUP** SERVICE CENTER  
800-424-STEP  
motiongroup.com  
PO BOX 669 CLOVIS, CA 93613-0669 TEL: 559-325-2727 FAX: 559-325-7117

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MINI-STEP QUAD-STEP AUTO-PARK DIAL-POT MMA PRINTER PORT DRIVER

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